Transformation of Software Support Facilities

Evolving toward the “Lean AISF”

Quality Production On Time

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Outline

- What is “Lean” ?
- What is an “AISF” ?
- What is a “Lean AISF” ?

What is “Lean” ?

Lean Now!

In response to World War II, Japan applied Western manufacturing principles to aerospace challenges. Without access to capital and lacking natural resources, they couldn’t adopt Western style manufacturing, but instead adapted it to their circumstances. Academic researchers dubbed their approach “lean production.”

Lean Aerospace Initiative

Toyota Production System

Taiichi Ohno

Shigeo Shingo

What is “Lean” ?

- Specify value:
  - Defined by the customer
- Identify the value stream:
  - Map process of transforming inputs to outputs
  - Identify and eliminate waste
- Emphasize “Flow”
- Customers pull value
- Kaizen:
  - Continuous improvement

- Adapted from James Womack and Daniel T. Jones, Lean Thinking (Simon & Schuster, New York, 1996)

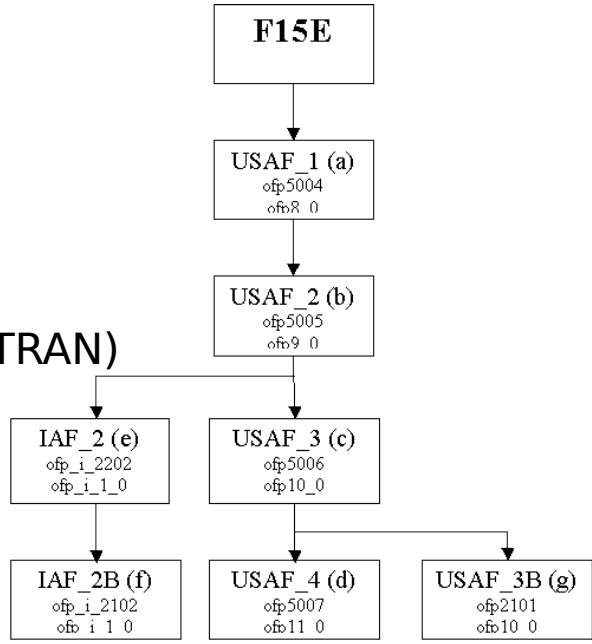
What is an AISF ?

- Terminology
  - OFP = Operational Flight Program
  - AISF = Avionics Integration Support Facility

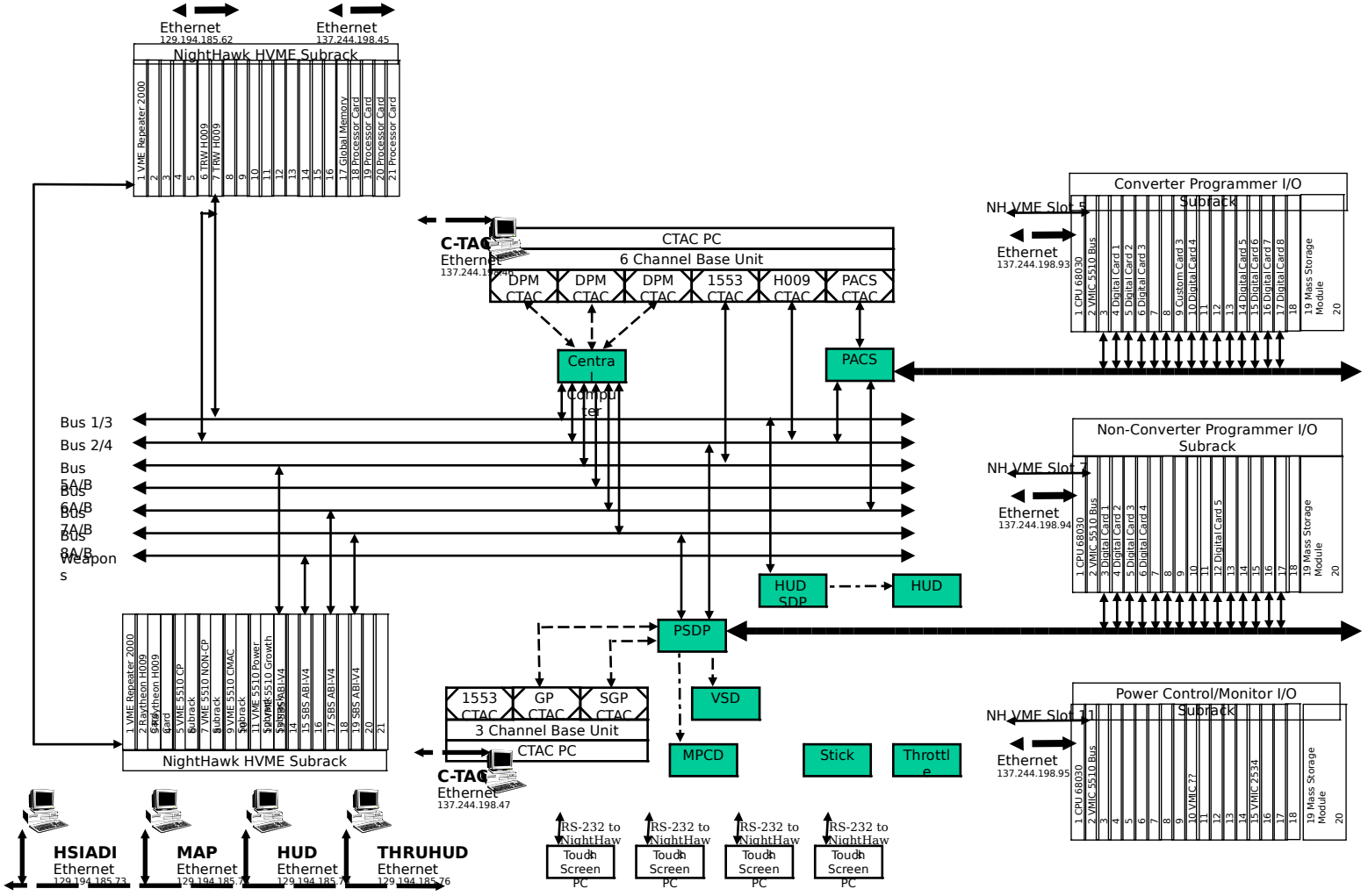
- An AISF is a real-time, closed-loop, hardware-in-the-loop system consisting of avionics hardware, signal processing hardware and software, and simulation software.
- Provides all of the required stimulation so that the avionics/OFPs respond as though they were in the aircraft.
- The AISF “customer” is the OFP engineer.

Avionics Portion of F-15 AISF

- We support **3** major customers
  - US Air Force (USAF)
  - Israeli Air Force (IAF)
  - Royal Saudi Air Force (RSAF)
- On **3** distinct aircraft configurations
  - F-15A-D (MSIP)
  - F-15E
  - F-15I
- Results in **16** distinct software configurations
  - Across **3** levels (Test, Verify, Config)
  - And **3** programming languages (Ada, C, and FORTRAN)
- Which run on many computers
  - **7** integration benches **33** VME racks **79** PCs
- At last count
  - **911** executable programs
  - **11,910** source files
  - Over **8 million** lines of AISF source code



Integration Bench System Diagram



AISF “As Is” State

- Most existing AISFs
  - were built in the late 1980s and early 1990s,
  - based on older minicomputer hardware that is expensive to maintain,
  - use proprietary operating systems and/or software development toolsets that are no longer supported by industry.
- Expensive to maintain
  - Vendor support contracts
  - Obsolete hardware and software
    - Broken components can’t be repaired
    - Replacement components can’t be purchased
    - Knowledge base vanishing
- Unable to use latest technology
  - 2GB limit on simulation host computer hard drives

AISF “To Be” State

- Updated AISF is
  - based on relatively inexpensive computer hardware
  - conforms to open industry standards
  - uses Open Source software where appropriate
- Less expensive to maintain
  - fewer support contracts and software licenses
- Able to use latest technology
  - faster cycle time to meet new requirements
  - leaner modification/support process
  - less expensive to modify over time

Lean AISF Example APG-70 Radar Bench

- Graphical User Interface (GUI)
- Before
  - Hardware: Silicon Graphics Onyx
    - Support Contract: $61K annual
  - Software: UIMX
    - Vendor no longer exists
- After
  - Hardware: Linux PC
    - Support Contract: $0
  - Software: Tcl/Tk
    - Open standard
- Cost Savings: $61K annual

Lean AISF Example
APG-70 OFP Toolset

- OFP source code and toolset
- Before
  - Hardware: IBM 9221 Model 170
    - Support Contract: $103K annual
- After
  - Hardware: Intel server
  - Software: FLEX-S emulation of IBM
    - Support Contract: $33K annual
- Cost Savings: $70K annual

Lean AISF Example APG-70 Simulation

- Real-time simulation
- Before
  - Hardware: VAXstation 4000
    - Support Contract: $44K annual
  - VMS
- After
  - Hardware: Motorola MV2400 PowerPC
  - Software: VxWorks
    - License: $4K
- Cost Savings: $40K annual

Lean AISF Example APG-70 Simulation

- SCRAMnet reflective memory interface
- Before
  - Hardware: SCRAMnet reflective memory interface
  - Support: Obsolete QBus
    - No longer supported by vendor
    - One spare in existence
- After
  - Hardware: Industry standard Ethernet backbone
  - Software: RTI NDDS Network Data Delivery System

Lean AISF Example Avionics Benches

- OFP source code and toolset
- Before
  - Hardware: Concurrent NightHawk 5808
    - Support Contract: $333 K annual
- After
  - Hardware: Intel servers
  - Software: Linux
  - Support Contract: $0K annual
- Cost Savings: $333K annual

Processes Due for Improvement

- Documentation Generation
- Software Build Process
- Software Configuration Management
- Automated Test via Scripts
- Problem Reporting

Trade Studies

- Configuration Management Tools
- Real-Time Operating Systems for VME racks
- User Interfaces
- Synthetic Mission Displays

Backup Slides

Backup Slides

- "We're passing on our lessons learned. And we're still a work in progress. Because one of the most important things we've learned is Lean Electronics, when done properly, is never done.“
  - Tom Regan, plant manager at the Rockwell Collins Decorah, Iowa plant.
  - This Lean Electronics (sm) model facilty reduced their entire plant work-in-process by 46%.

The Ten Simple Rules of Lean Programming

Eliminate Waste

Minimize Artifacts

Satisfy All Stakeholders

Deliver As Fast As Possible

Decide As Late As Possible

Decide As Low As Possible

Deploy Comprehensive Testing

Learn By Experimentation

Measure Business Impact

Optimize Across Organizations

Source: Mary Poppendieck